FOUNDATION INVESTIGATION
PROPOSED MAIN LOBBY
KUAKINI HOSPITAL
HONOLULU, OAHU, HAWAII
FOR
KUAKINI HOSPITAL

DAMES & MOORE JOB NO. 9807-002-11

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DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

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September 9, 1975

Group Architects Collaborative
926 Bethel Street
Honolulu, Hawaii 96813

Attention: Mr. Frank Wong

Gentlemen:

Transmitted herewith are four copies of our report entitled "Foundation Investigation, Proposed Main Lobby, Kuakini Hospital, Honolulu, Oahu, Hawaii, for Kuakini Hospital".

The scope of our work was presented in our proposal dated July 21, 1975 and this investigation has generally conformed to the proposal. For convenience, a brief summary of our recommendations is presented on the first page of this report. A description of our field exploration procedures and the laboratory testing results are presented in the Appendix.

Samples of subsurface materials not destroyed during our laboratory testing are being stored in our laboratory for possible inspection and examination. According to our normal schedule, these smaples will be discarded six months from this date, unless otherwise requested.

It has been a pleasure performing this investigation for you. Should you have any questions concerning the contents of this report, please contact us.

Yours very truly,

DAMES & MOORE

Mei-Ban Lo

MBL:LJC:pdc

FOUNDATION INVESTIGATION

PROPOSED MAIN LOBBY

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FOR

KUAKINI HOSPITAL

SUMMARY

Foundation support can be achieved by spread or wall footings embedded in the silty layer (weathered basalt) overlying the basalt bedrock.

No major problems are anticipated during foundation excavation. Utility lines should be disconnected and rerouted prior to excavation. Boulders can be excavated using convential heavy equipment.

INTRODUCTION

This report presents the results of our foundation investigation performed for the proposed Main Lobby for Kuakini Hospital, to be located on the east side of the existing Administration Building of the hospital. The general area of the site with respect to the surroundings is illustrated on the Map of Area, Plate 1. The approximate location of the proposed structure and the boring location are shown on the Plot Plan, Plate 2.

PROJECT CONSIDERATIONS

We understand that the proposed structure will be one-story in height in an area of approximately 88 feet by 64 feet. The finished grade will be at the same elevation as the basement floor of the existing Administration Building at 60.58 feet Mean Sea Level. The existing surface elevation is approximately 69 feet Mean Sea Level. We understand that the proposed facility will join with the proposed parking structure by an underground corridor. We also understand that the existing electrical transformer room will remain at the site.

The grading plans have not been finalized as of the date of this report. Foundation loads are not known at present, but they are believed to be relatively light.

PURPOSE AND SCOPE OF WORK

The general purpose of the work performed in this investigation includes the following:

1) To generally locate and identify the various types of materials underlying the site;
2) To analyze the engineering properties of the subsurface materials encountered; and,
3) To make foundation related recommendations for design and construction of the proposed facility.

In order to achieve the aforementioned purposes, the following scope of work was undertaken:

1) One boring was drilled to a depth of 31 feet to recover undisturbed samples of the subsurface materials. A log of boring was maintained and detailed observations of site conditions pertinent to this exploration were made and recorded by our field engineer.

2) Various tests were performed on selected undisturbed samples to analyze their engineering properties.

3) An engineering analysis was conducted to develop recommendations for foundation design and construction of the proposed facility.

4) All recommendations and related information were formalized and incorporated into this report.

A detailed description of the field exploration and laboratory testing is presented in the Appendix of this report. The Log of Boring and results of the field exploration and laboratory tests are also included in the Appendix.

SITE CONDITIONS

SURFACE CONDITIONS

The site of the proposed facility is located on the east side and adjacent to the existing Administration Building. The area is covered mostly by a grassy lawn in addition to a transformer room and two recessed walkways.

There are several utility lines, particularly a primary and a secondary electrical line and a telephone main line all located at approximately two feet below the existing ground surface at the site. These lines connect to utility boxes located adjacent to the parking lot curb to the existing transformer room. The finish floor of the transformer room is at approximately the same elevation as the finish floor of the adjoining Administration Building. There are two recessed walkways, one located between the transformer room and the existing Administration Building and the second located adjacent to the south wing of the building. The surface elevation of the site varies from approximately 68 feet to 70 feet (Mean Sea Level Datum).

SUBSURFACE CONDITIONS

To explore the subsurface conditions at the site, one boring was drilled to a depth of 31.0 feet. The subsurface materials encountered in this boring correlate reasonably well with the information obtained during previously drilled borings in the general area. Materials encountered in this boring consisted of stiff alluvial clayey silt and boulder matrix to a depth of 10.0 feet. The boulders varied in size approximately from 1.0 feet to 2.0 feet in diameter.

Underlying the alluvial material, a very stiff mottled silt stratum (weathered basalt) was encountered, from a depth of 10.0 to 16.0 feet. From 16.0 feet, the material grades into a dense mottled silty sand and gravel (partially weathered basalt) to a depth of 20.0 feet. A hard basalt formation was encountered at 20 feet below the surface.

DISCUSSIONS AND RECOMMENDATIONS

FOUNDATION SUPPORT

Spread and/or continuous footings could be used for the foundation of the proposed facility. We recommend that the footings be placed in the aforementioned very stiff mottled silt stratum (weathered basalt), at the elevation of approximately 59 feet. Footings can be designed using an allowable bearing pressure of 3,000 pounds per square foot. The minimum footing width should be 24 inches. Total settlement of the footings is anticipated to be minimal.

We recommend that six inches of open graded granular cushion material be provided under the slabs. The cushion material should be compacted prior to slab pouring. We also recommended that a vapor barrier be used under the slab.

SITE PREPARATION AND EARTHWORK

All existing utility lines should be disconnected and rerouted prior to excavation. Care should be exercised during construction in the congested area to avoid damage to the existing structures. OSHA regulations should be followed during excavation operations.

Due to the large quantity and size of boulders existing in the material to be excavated, we do not recommend this excavated material for use in backfill. We recommed that imported granular material be utilized for backfill purposes, if required. The backfill should be compacted in six-inch lifts to a minimum of 90 percent of the maximum dry density as determined by the ASTM test designation D-1557.

LATERAL EARTH PRESSURE

A uniform lateral pressure of 250 pounds per square foot per linear foot should be used for basement wall design. An open graded gravel should be placed behind the walls with a perforated drain pipe to remove all water from behind the walls.

FIELD INSPECTION

Recommendations made in this report are based upon the soil encountered in the boring drilled during our investigation. Should any different conditions be encountered

during construction, a foundation engineer should be consulted so that appropriate modifications may be implemented, if necessary. We recommend that foundation excavation be inspected and approved by a qualified soils engineer. Additionally, we recommend that fill and backfill placement also be inspected and approved by a qualified soils engineer.

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The following Plates and Appendix are attached and complete this report.

Plate 1 Map of Area

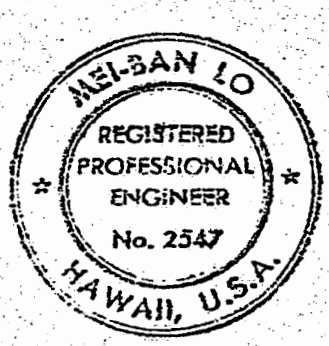
Plate 2 Plot Plan

Appendix Field Exploration and Laboratory Testing

Respectfully submitted,

DAMES & MOORE

Mei-Ban Lo



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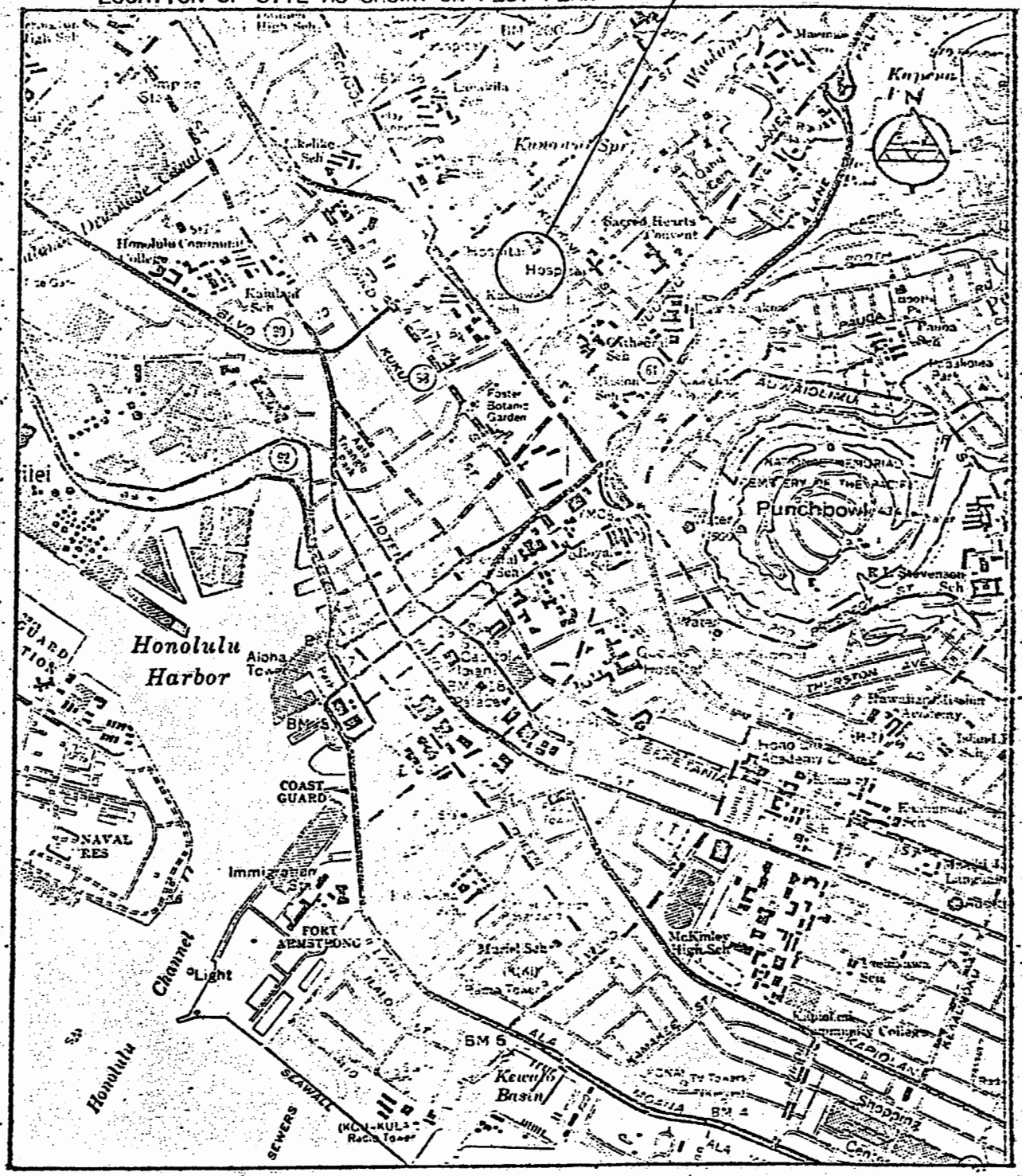
LOCATION OF SITE AS SHOWN ON PLOT PLAN



MAP OF AREA

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

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PLATE 1

REVISIONS BY DATE

FILE

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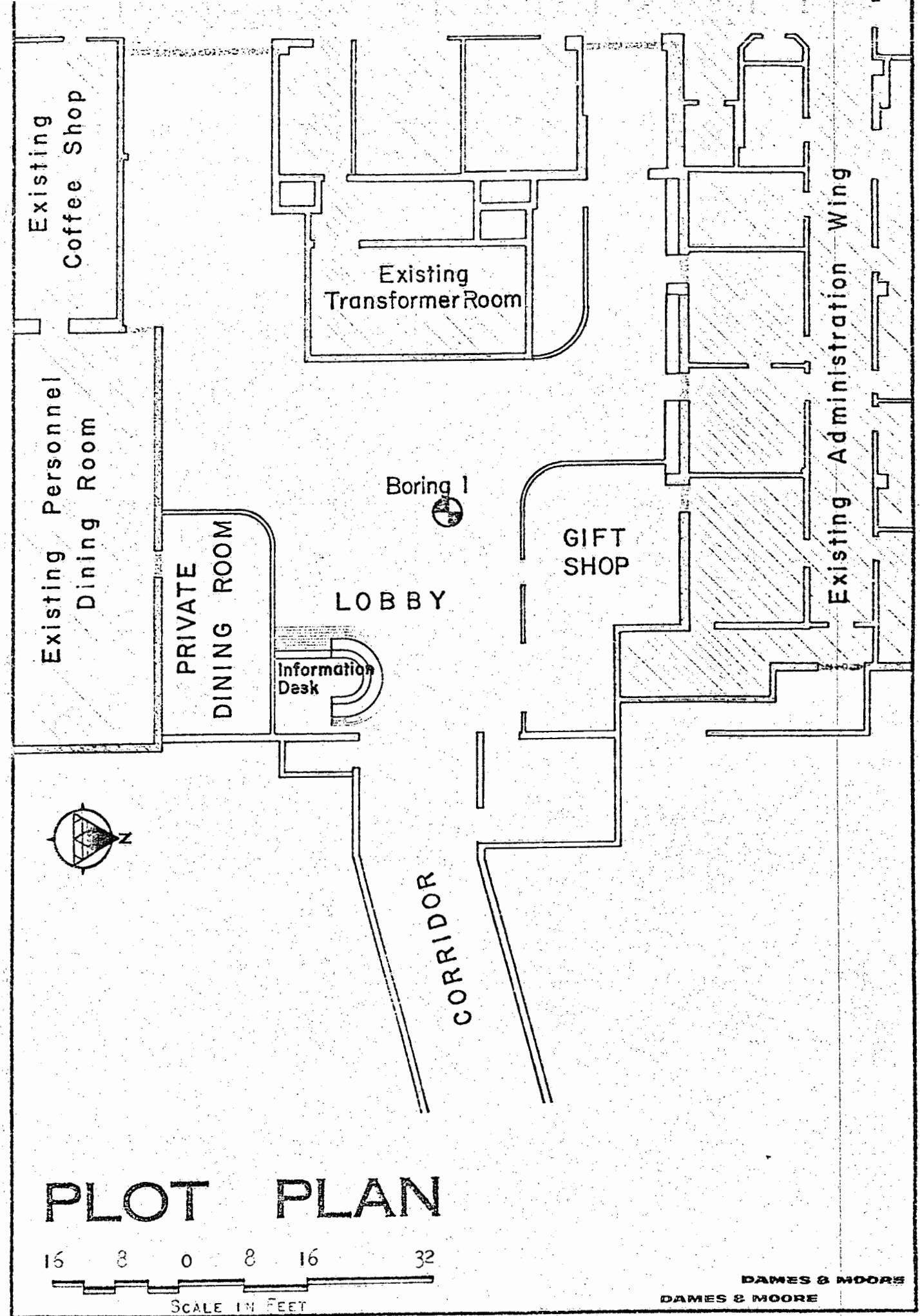

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PLATE 2

REVISIONS BY DATE

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APPENDIX

FIELD EXPLORATION AND LABORATORY TESTING

FIELD EXPLORATION

The subsurface conditions were explored by drilling one boring to a depth of 31.0 feet. The boring was drilled by Continental Drilling Hawaii, Inc., with a truck-mounted Failing 250 drill rig. Anticipating many boulders, the boring was drilled using a rock bit and rotary-wash equipment. Subsurface samples were recovered using a Dames & Moore Type U sampler, illustrated on Exhibit A-1.

A Dames & Moore field engineer was present at the site during the field exploration to technically direct the drilling operations, to maintain a log, to identify the samples recovered, and to observe the site conditions.

The location of the boring and pertinent existing conditions are illustrated on the Plot Plan, Plate 2. Descriptions and classification of subsurface conditions are presented on the Log of Borings, Plate A-1. The subsurface materials were classified according to the Unified Soil Classification System presented on Plate A-2.

LABORATORY TESTING

Laboratory tests were conducted in our office on selected samples of the subsurface materials. A description of the tests and test results are presented below:

Unconsolidated-Undrained Triaxial Compression Test - Two samples were subjected to this test in order to evaluate their strength characteristics. The tests were conducted according to the test procedures presented on Exhibit A-2. The results of the tests are summarized below:

Sample No.	Depth (ft.)	Field Moisture (%)	Field Dry Density (pcf)	Confining Pressure (psf)	Peak Deviator Stress (psf)
2	12.5	43.4	80.4	1500	3818
4	19.0	54.2	70.2	2300	1296

Consolidation Test - One consolidation test was performed to evaluate the compressibility of the soil. A description of the test procedure is presented on Exhibit A-3. Test results are presented on Plate A-3.

Expansion Test - In order to evaluate the expansive characteristics of the silty material, an expansion test was performed on a selected sample. A load of 100 pounds per square foot was used as surcharge. The results are:

Sample No.	Depth (ft.)	Natural Moisture Content (%)	Percent Expansion
2	12.2	54.2	0.39

Moisture Content and Dry Density Determinations -

All samples were subjected to moisture content and dry density determinations. The results of the moisture and density determinations are tabulated on the Log of Borings at the approximate depth.

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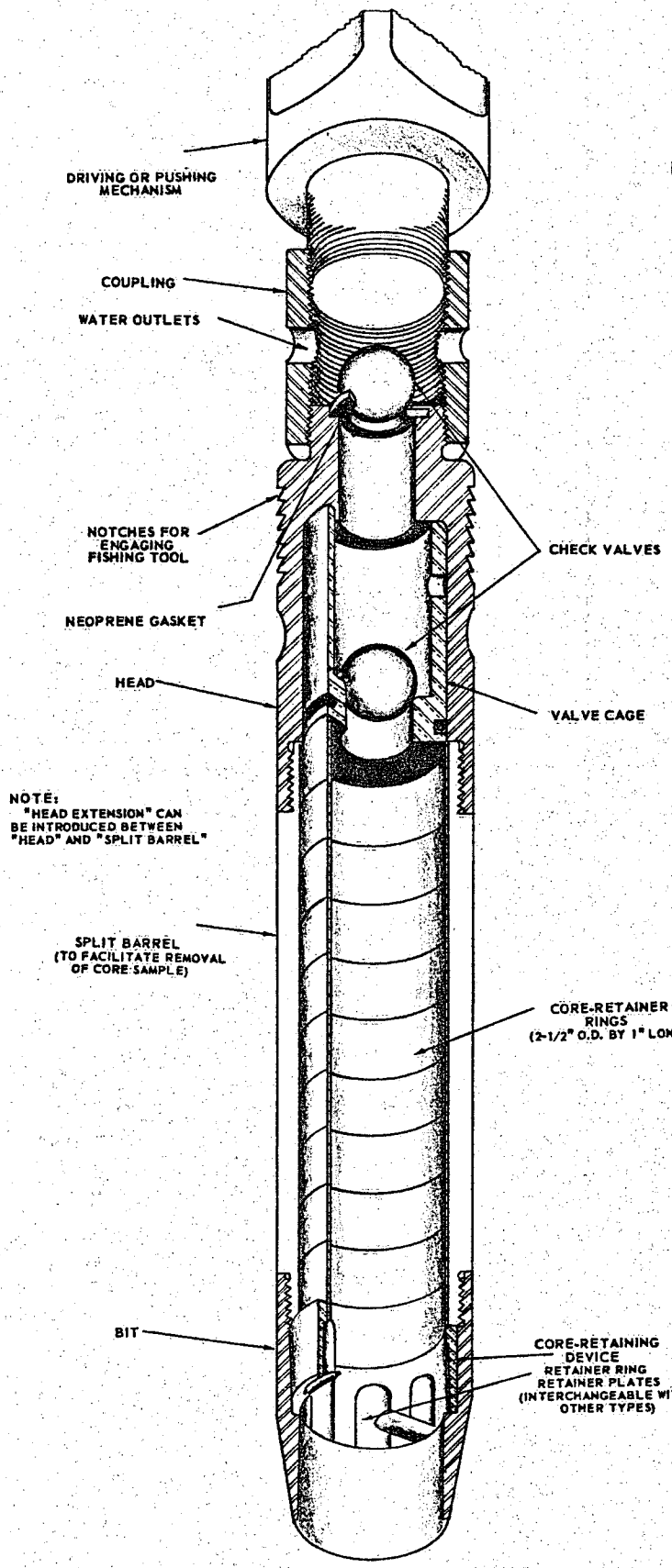
The following Exhibits and Plates are attached and complete this appendix.

Exhibit A-1	Soil Sampler Type U
Exhibit A-2	Methods of Performing Unconsolidated-Undrained Triaxial Compression Tests
Exhibit A-3	Method of Performing Consolidation Tests
Plate A-1	Log of Boring, Boring 1
Plate A-2	Unified Soil Classification System
Plate A-3	Consolidation Test Data

SOIL SAMPLER TYPE U

FOR SOILS DIFFICULT TO RETAIN IN SAMPLER



ALTERNATE ATTACHMENTS

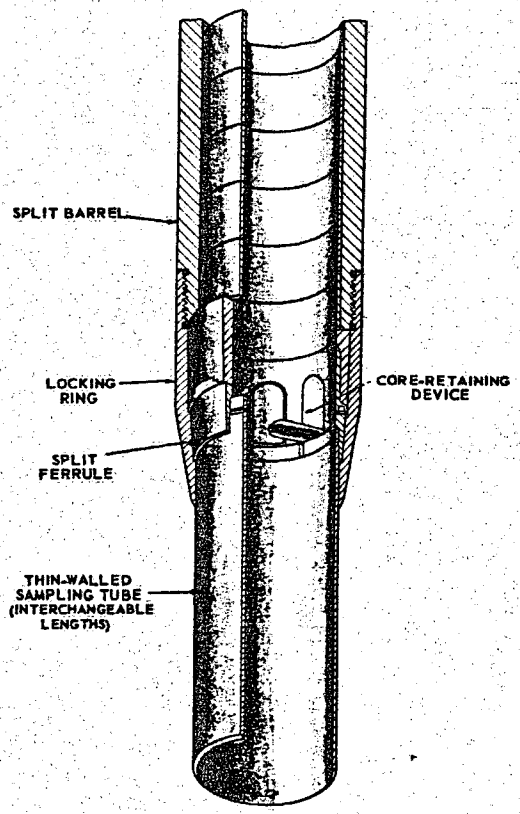


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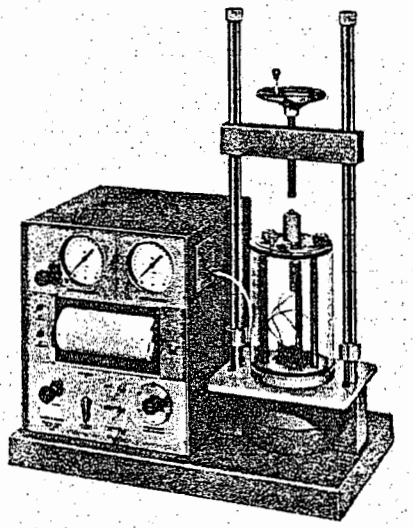
EXHIBIT A-1

METHODS OF PERFORMING UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS

THE SHEARING STRENGTHS OF SOILS ARE DETERMINED FROM THE RESULTS OF UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS. IN TRIAXIAL COMPRESSION TESTS THE TEST METHOD AND THE MAGNITUDE OF THE CONFINING PRESSURE ARE CHOSEN TO SIMULATE ANTICIPATED FIELD CONDITIONS.

UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS ARE PERFORMED ON UNDISTURBED OR REMOLDED SAMPLES OF SOIL APPROXIMATELY SIX INCHES IN LENGTH AND TWO AND ONE-HALF INCHES IN DIAMETER. THE TESTS ARE RUN EITHER STRAIN-CONTROLLED OR STRESS-CONTROLLED. IN A STRAIN-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO A CONSTANT RATE OF DEFLECTION AND THE RESULTING STRESSES ARE RECORDED. IN A STRESS-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO EQUAL INCREMENTS OF LOAD WITH EACH INCREMENT BEING MAINTAINED UNTIL AN EQUILIBRIUM CONDITION WITH RESPECT TO STRAIN IS ACHIEVED.



TRIAXIAL COMPRESSION TEST UNIT

YIELD, PEAK, OR ULTIMATE STRESSES ARE DETERMINED FROM THE STRESS-STRAIN PLOT FOR EACH SAMPLE AND THE PRINCIPAL STRESSES ARE EVALUATED. THE PRINCIPAL STRESSES ARE PLOTTED ON A MOHR'S CIRCLE DIAGRAM TO DETERMINE THE SHEARING STRENGTH OF THE SOIL TYPE BEING TESTED.

UNCONFINED COMPRESSION TESTS CAN BE PERFORMED ONLY ON SAMPLES WITH SUFFICIENT COHESION SO THAT THE SOIL WILL STAND AS AN UNSUPPORTED CYLINDER. THESE TESTS MAY BE RUN AT NATURAL MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SOILS.

IN A TRIAXIAL COMPRESSION TEST THE SAMPLE IS ENCASED IN A RUBBER MEMBRANE, PLACED IN A TEST CHAMBER, AND SUBJECTED TO A CONFINING PRESSURE THROUGHOUT THE DURATION OF THE TEST. NORMALLY, THIS CONFINING PRESSURE IS MAINTAINED AT A CONSTANT LEVEL, ALTHOUGH FOR SPECIAL TESTS IT MAY BE VARIED IN RELATION TO THE MEASURED STRESSES. TRIAXIAL COMPRESSION TESTS MAY BE RUN ON SOILS AT FIELD MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SAMPLES. THE TESTS ARE PERFORMED IN ONE OF THE FOLLOWING WAYS:

UNCONSOLIDATED-UNDRAINED: THE CONFINING PRESSURE IS IMPOSED ON THE SAMPLE AT THE START OF THE TEST. NO DRAINAGE IS PERMITTED AND THE STRESSES WHICH ARE MEASURED REPRESENT THE SUM OF THE INTERGRANULAR STRESSES AND PORE WATER PRESSURES.

CONSOLIDATED-UNDRAINED: THE SAMPLE IS ALLOWED TO CONSOLIDATE FULLY UNDER THE APPLIED CONFINING PRESSURE PRIOR TO THE START OF THE TEST. THE VOLUME CHANGE IS DETERMINED BY MEASURING THE WATER AND/OR AIR EXPELLED DURING CONSOLIDATION. NO DRAINAGE IS PERMITTED DURING THE TEST AND THE STRESSES WHICH ARE MEASURED ARE THE SAME AS FOR THE UNCONSOLIDATED-UNDRAINED TEST.

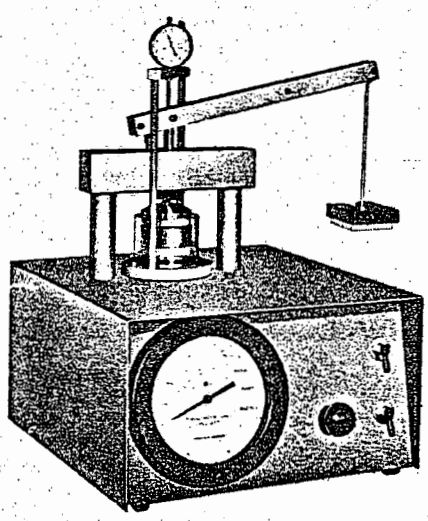
DRAINED: THE INTERGRANULAR STRESSES IN A SAMPLE MAY BE MEASURED BY PERFORMING A DRAINED, OR SLOW, TEST. IN THIS TEST THE SAMPLE IS FULLY SATURATED AND CONSOLIDATED PRIOR TO THE START OF THE TEST. DURING THE TEST, DRAINAGE IS PERMITTED AND THE TEST IS PERFORMED AT A SLOW ENOUGH RATE TO PREVENT THE BUILDUP OF PORE WATER PRESSURES. THE RESULTING STRESSES WHICH ARE MEASURED REPRESENT ONLY THE INTERGRANULAR STRESSES. THESE TESTS ARE USUALLY PERFORMED ON SAMPLES OF GENERALLY NON-COHESIVE SOILS, ALTHOUGH THE TEST PROCEDURE IS APPLICABLE TO COHESIVE SOILS IF A SUFFICIENTLY SLOW TEST RATE IS USED.

AN ALTERNATE MEANS OF OBTAINING THE DATA RESULTING FROM THE DRAINED TEST IS TO PERFORM AN UNDRAINED TEST IN WHICH SPECIAL EQUIPMENT IS USED TO MEASURE THE PORE WATER PRESSURES. THE DIFFERENCES BETWEEN THE TOTAL STRESSES AND THE PORE WATER PRESSURES MEASURED ARE THE INTERGRANULAR STRESSES.

Method Of Performing Consolidation Tests

Consolidation tests are performed to evaluate the volume changes of soils subjected to increased loads. Time-consolidation and pressure-consolidation curves may be plotted from the data obtained in the tests. Engineering analyses based on these curves permit estimates to be made of the probable magnitude and rate of settlement of the tested soils under applied loads.

Each sample is tested within brass rings two and one-half inches in diameter and one inch in length. Undisturbed samples of in-place soils are tested in rings taken from the sampling device in which the samples were obtained. Loose samples of soils to be used in constructing earth fills are compacted in rings to predetermined conditions and tested.



DEAD LOAD-PNEUMATIC CONSOLIDOMETER

In testing, the sample is rigidly confined laterally by the brass ring. Axial loads are transmitted to the ends of the sample by porous disks. The disks allow drainage of the loaded sample. The axial compression or expansion of the sample is measured by a micrometer dial indicator at appropriate time intervals after each load increment is applied. Each load is ordinarily twice the preceding load. The increments are selected to obtain consolidation data representing the field loading conditions for which the test is being performed. Each load increment is allowed to act over an interval of time dependent on the type and extent of the soil in the field.

BORING 1

SURFACE ELEVATION 69.0 FEET
MSL DATUM

MOISTURE CONTENT IN %	DRY DENSITY IN PCF	BLOWS/FT. ON SAMPLER	CORE AND % RECOVERY	SAMPLES AND/OR CORES	DEPTH IN FEET	GRAPH SYMBOL	LETTER SYMBOL	DESCRIPTION
					0		MH	BROWN CLAYEY SILT, STIFF, WITH ROOTS (FILL)
58.5	66.5	19/9"					MH	MOTTLED TAN AND BROWN CLAYEY SILT, STIFF, INCORPORATED IN DENSE BASALT BOULDERS, 1 TO 2 FEET IN DIAMETER
			NX 23%		5			GRADES TO VERY STIFF WITH TRACES OF GRAVEL
		27			10		MH	MOTTLED GRAY AND BROWN SILT, VERY STIFF (HIGHLY WEATHERED BASALT)
43.4	80.4	30						GRADES TO STIFF
					15			BASALT BOULDER
49.1	74.7	16					SM	MOTTLED GRAY, WHITE AND BROWN SILTY SAND AND GRAVEL, DENSE (PARTIALLY WEATHERED BASALT)
54.2	70.2	20			20			GRAY BASALT, HARD
			NX 75%					TRACES OF CALCITE AND WEATHERING
					25			WEATHERED FRACTURE WITH CALCITE DEPOSIT
			NX 60%					GRADES TO VERY HARD BASALT WITH WEATHERED FRACTURES AND CALCITE
					30			BORING COMPLETED AT 31.0 FEET ON 8-15-75
								NO WATER ENCOUNTERED

NOTES:

- ▩ -DEPTH AT WHICH UNDISTURBED SAMPLE WAS TAKEN
- ⊠ -DEPTH AT WHICH DISTURBED SAMPLE WAS TAKEN
- □ -DEPTH AT WHICH SAMPLE WAS LOST DURING EXTRACTION
- I -DEPTH AND LENGTH OF CORE RUN

DRIVING ENERGY - 270-LB WEIGHT DROPPING 30 INCHES

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PLATE A-1

REVISIONS BY DATE

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS — MORE THAN 50 % OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS — MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS — MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS — MORE THAN 50 % OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS — LIQUID LIMIT LESS THAN 50			ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS — LIQUID LIMIT GREATER THAN 50			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICTY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

FOR LABORATORY CLASSIFICATION OF FINE-GRAINED SOILS

NOTES:

1. DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE CLASSIFICATIONS.
2. WHEN SHOWN ON THE BORING LOGS, THE FOLLOWING TERMS ARE USED TO DESCRIBE THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE COMPACTNESS OF COHESIONLESS SOILS.

COHESIVE SOILS	(APPROXIMATE SHEARING STRENGTH IN KSF)
VERY SOFT	LESS THAN .25
SOFT	0.25 TO 0.5
MEDIUM STIFF	0.5 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	GREATER THAN 4.0

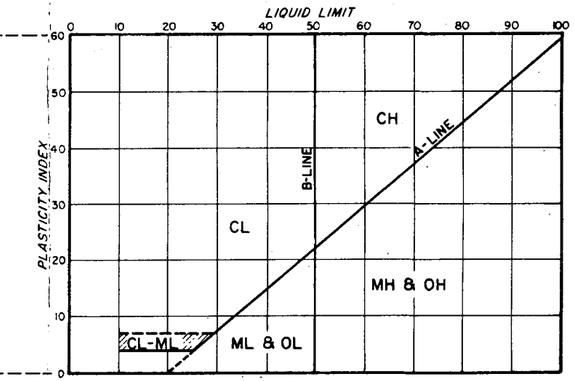
COHESIONLESS SOILS	
VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	THESE ARE USUALLY BASED ON AN EXAMINATION OF SOIL SAMPLES, PENETRATION RESISTANCE, AND SOIL DENSITY DATA.

GRADATION CHART

MATERIAL SIZE	PARTICLE SIZE			
	LOWER LIMIT		UPPER LIMIT	
	MILLIMETERS	SIEVE SIZE*	MILLIMETERS	SIEVE SIZE*
SAND				
FINE	.074	#200*	0.42	#40*
MEDIUM	0.42	#40*	2.00	#10 *
COARSE	2.00	#10*	4.76	#4 *
GRAVEL				
FINE	4.76	#4 *	19.1	3/4" *
COARSE	19.1	3/4" *	76.2	3" *
COBBLES	76.2	3" *	304.8	12 *
BOULDERS	304.8	12 *	914.4	36"

*U.S. STANDARD * CLEAR SQUARE OPENINGS

PLASTICITY CHART



SAMPLES

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- I INDICATES LENGTH OF CORING RUN

NOTE:
DEFINITIONS OF ANY ADDITIONAL DATA REGARDING SAMPLES ARE ENTERED ON THE FIRST LOG ON WHICH THE DATA APPEAR.

UNIFIED SOIL CLASSIFICATION SYSTEM

DAMES & MOORE

PLATE A-2

(REV. 3-65)

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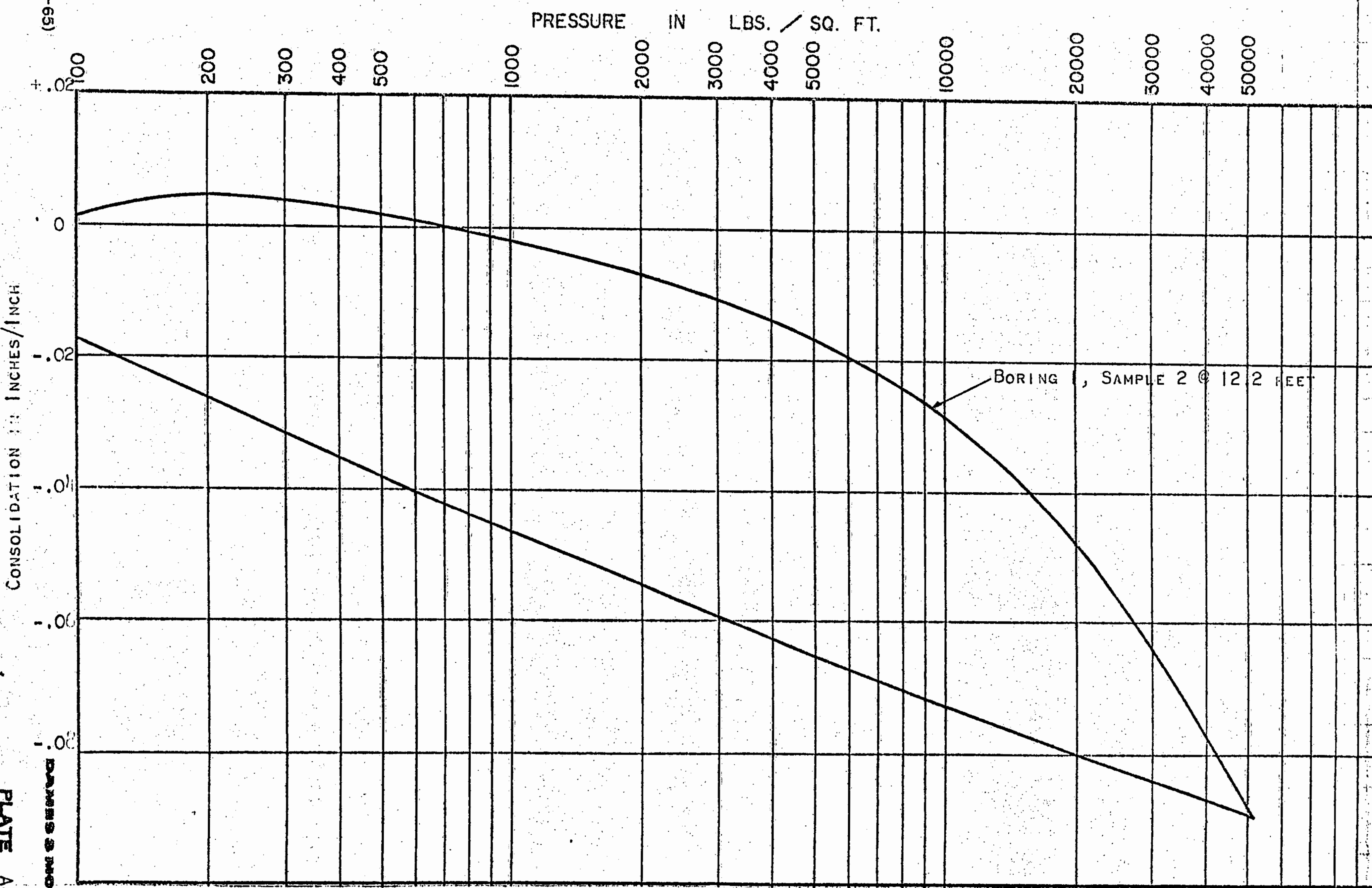

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PLATE A-3